



## **Librational response of Europa, Ganymede, and Callisto for a non-Keplerian orbit**

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The Galilean satellites will be the target of the future NASA-ESA space mission called Europa Jupiter System Mission (EJSM-Laplace). One of the objectives of this mission is to determine geophysical properties of these satellites, in particular to characterize the water ocean beneath their icy shell. Such an ocean may be crucial for the emergence of habitable worlds in the Solar system.

The measurement of the librational motion, which is a variation of the uniform rotation in the equatorial plane of the satellite, can be a useful technique to prove the existence of a putative ocean beneath the icy shell. In particular, the amplitude of the libration will be increased by the existence of the ocean because the liquid layer allows a differential rotation between the icy shell and the solid interior. The librations will present a wide spectrum of frequencies due to the orbital variations of the satellite. The long period librations appear to be dominant to the short period librations but their associated amplitudes are almost independent of geophysical parameters related to the ocean. Nevertheless, it will be necessary to take into account all librations in order to interpret the future spacecraft observations of the satellites rotational motion. For Europa, we also identified a short-period libration with period close to twice the orbital period, which could have been resonantly amplified in the history of Europa. For Ganymede, we also found a possible resonance between a proper period and a forced period when the thickness of the icy shell is around 50 km. The librations of Callisto are dominated by solar perturbations.